Nitrogen Cycle

The element Nitrogen is important to living organisms and is used in the production of amino acids, proteins and nucleic acids (DNA, RNA). Molecular nitrogen (N_2) is the most abundant gas in the atmosphere. However, only a few single-cell organisms are able to utilize this nitrogen form directly. These include the bacteria species Rhizobium, which lives on the root nodules of legumes, and cyanobacteria (sometimes called blue-green algae), which are ubiquitous to water and soil environments. In order for multi-cellular organisms to use nitrogen, its molecular form (N_2) must be converted to other compounds, e.g., nitrates or ammonia. This process is known as nitrogen fixation. Microbial organisms such as cyanobacteria carry out most of the earth's nitrogen fixation. The industrial manufacture of fertilizers, emissions from combustion engines, and nitrogen burning in lightning account for a smaller fraction.

The nitrogen cycle is largely dependent on microbrial processes. Bacteria fix nitrogen from the atmosphere in the form of ammonia (NH_3) and convert the ammonia to nitrate (NO_3^-).

Ammonia and nitrate are absorbed by plants through their roots. Humans and animals get their nitrogen supplies by eating plants or plant-eating animals. The nitrogen is returned to the cycle when bacteria decompose the waste or dead bodies of these higher organisms, and in the process, convert organic nitrogen into ammonia. In a process called denitrification, other bacteria convert ammonia and nitrate into molecular nitrogen and nitrous oxide (N_2O). Molecular nitrogen is thus returned to the atmosphere to start the cycle over again.

Humans have disturbed the nitrogen cycle in recent history by activities involving increased fixation of nitrogen.

Most of this increased nitrogen fixation results from the commercial production of fertilizers and the increased burning of fuels (which converts molecular nitrogen to nitric oxide, NO). The use of commercial fertilizers on agricultural lands increases the runoff of nitrates into aquatic environments.

This increased nitrogen runoff stimulates the rapid growth of algae. When the algae die, the water becomes depleted in oxygen and other organisms die. This process is known as eutrophication. The excessive use of fertilizers also stimulates the microbial denitrification of nitrate to nitrous oxide. Increased atmospheric levels of nitrous oxide are thought to contribute to global warming. Nitric oxide added to the atmosphere combines with water to form nitric acid (HNO_3), and when nitric acid dissolves in water droplets, it forms acid rain. Acid rain damages healthy trees, destroys aquatic systems and erodes building materials such as marble and limestone.